| POLI ESCOLA SUPERIOR TECNOLOGIA GESTÃO TÉCNICO GUARDA | **SUBJECT DESCRIPTION** | **MODELO** PED.013.03 |
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| *Course* | **Energy and Environment** | | | | | |
| *Subject* | **Environmental Geotechnics** | | | | | |
| *Academic year* | 2023-2024 | *Curricular year* | 3rd | *Study period* | 1st semester | |
| *Type of subject* | Compulsory | *Student workload (H)* | Total: 154 | Contact: 60 | *ECTS* | 5,5 |
| *Professor(s)* | Ana Maria Antão | | | | | |
| ☒ *Area/Group Coordinator* ☐ *Head of Department* *(select)* | José Carlos Almeida | | | | | |

## PLANNED SUBJECT DESCRIPTION

### 1. LEARNING OBJECTIVES

*The student will develop skills that allows discuss in a reasoned manner and solve problems within the Environmental Geotechnics, to build skills with a view to their professional performance. So, the students should acquire the following skills: Known how to calculate the hydraulic quantities and state od stress of the soil for one-dimensional and two-dimensional flows using a flow net; Know how to determinate the state of stress with the water under hydrostatic or hydrodynamic regime in characteristic points of the ground; Be able to perform the laboratory tests used to evaluate the physical characteristics, permeability, and compressibility of the soils.Identified the mean geotechnical and geoenvironmental problems.*
*Identifying the geotechnical scope of environmental impacts resulting from construction activity.*

### 2. PROGRAMME

*TERMINOLOGY and DEFINITIONS IN GEOTECHNICAL ENGINNERING*

*STATE OF STRESS IN THE GROUND*

*Concept of effective stress state in saturated soils; Stress induced in soil mass by applied loads. Definition of total and effective stress. The pore water stress. Terzaghi effective stress principle. Geostatic stresses. Determination of the state of stress with the water under hydrostatic or hydrodynamic regime in a characteristic point of the ground due to civil engineering works like waste landfills. Laboratory determination of the total granulometric analysis of a soil.*

*WATER IN THE SOIL. PERMEABILITY AND PERCOLATION*

*Flow of water through the soils; Darcy's Law; Bernoulli theorem; Determination of the permeability coefficient in the lab an in the field; One-dimensional and two-dimensional percolation; Flow nets; Hydraulic instability. Laboratory determination of the permeability coefficient of a soil.*

*SOIL COMPACTION*

*Purpose of compaction of soils; factors affecting compaction; laboratory compaction tests; presentation of results; effects of water content during compaction; effects of increasing compaction effort; effects of soil type; in situ compaction; main types of compaction; in situ tests carried out during earthwork construction. Execution and analysis of soil compaction test.*

*WASTE LANDFILL*

*Current situation of solid waste in Portugal; geological and geotechnical studies for the implementation of sanitary landfill; landfills for disposal of solid waste – landfill technology; mechanical and hydraulically parameters; filters design; geotechnical characterization of solid urban waste; geotechnical and environmental landfill; national normalization for waste landfill design.*

*GEOSYNTHETICS*

*Characteristics, types, and functions; main properties of geo-synthetics and application examples for engineering works: reinforcement, erosion control, coastal protection, dams and channels, embarkments, landfills, railways and roads.*

*GEOLOGICAL HAZARDS – MASS MOVEMENTS*

*Notion of geological risks: inventory mapping, susceptibility, hazard, vulnerability, risk and multi-risk; geological risks by mass movements: stability analysis and stabilization techniques. Stability analysis of rock slopes through stereographic projection: Markland and Hocking methods; Hoek & Bray procedures. Stability of soil slopes through Taylor's and Hoek & Bray abacus.*

## 3. COHERENCE BETWEEN PROGRAMME AND OBJECTIVES

*The contents of this subject, are intended to provide the students with basic knowledge in the field of Environmental Geotechnics, enabling them to know, from the geotechnical point of view, the soils, their fundamental properties and characteristics, their applicability as construction material (compaction) in the embarkments, and understand its hydraulic behaviour and its compressibility, namely in sanitary landfills. The knowledge of geosynthetics is made by comparison with the properties and characteristics of soils. It is intended also to alert students for the geotechnical risk associates with the movement of soils in excavation slope and design.*

## 4. MAIN BIBLIOGRAPHY

*Theorical and practical notes provided by the teacher.*

*Exercises provided by the teacher.*

***Antão, A.** (2020)- Videos about the Proctor compaction test (IPG©)*

***Cabeças & Levi** (2006). Resíduos sólidos urbanos. Princípios e Processos. AEPSA.*

***Cornwell, D.** (1998). "Environmental Engineering". Mc Graw Hill.*

***Fang, H.Y.** (1997). "Introduction to environmental geotechnology". CRC Press*

***Fernandes, M.M.** (2006). "Mecânica dos Solos - Conceitos e Princípios Fundamentais". 1.º volume, FEUP.*

***Graig, R.F.** (2004). "Craig's Soil Mechanics". 7th Edition, Spon Press.*

***Head, K. H**. (1986). "Manual of Soil Laboratory Testing". Vol. 1,2,3. Pentech Press, London.*

*H**oek, H. & Bray, J.W.** (1981). Rock Slope Engineering. 3rd Edition, IMM, Londres.*

***Sarsby, R**. (2000). "Environmental Geotechnics" Thomas Telford.*

*Specific legislation.*

*National regulations*

*<u>Recommended sites</u>*

https://www.spgeotecnia.pt

https://cpga.spgeotecnia.pt

https://www.geosyntheticssociety.org

## 5. TEACHING METHODOLOGIES (INCLUDING EVALUATION)

*In the theoretical lessons, will be presented concepts and theories relating to the matters taught. Will use the lecture method with the use of digital platforms and PowerPoint. A study of work cases will be used as well as natural phenomena that demonstrate the importance of the concepts introduced. The theoretical and practical lessons will be solved worksheets. Practical lessons will be run laboratory tests. We use e-learning platforms to support the subject.*

*<u>Continuous assessment</u>: it's necessary obtaining positive validation in all reports of the laboratory tests done:*

- *Theoretical and practical test - 70 %*
- *Practical works developed by students - 30 %*

*Final assessment: the student who did not obtain approval in continuous assessment or did not use it, can get approved when the classification of the exam at the normal time or during the last assessment is bigger than ten values.*

## 6. COHERENCE BETWEEN TEACHING METHODOLOGIES AND OBJECTIVES

*To achieve the objectives of the UC, theoretical knowledge is taught regarding the fundamentals that explain the behavior of the soils, in addition to a practical component where the student applies a set of tools that allows him to predict and evaluate this behavior. At the same time, the student is subject to great laboratory activity to sustain the theoretical training and prepare him for future professional activity. Technical visits to geotechnical works in the region will also be proposed .*

## 7. ATTENDANCE

*Attendance is strongly recommended especially in practical classes and field/lab classes, but there is no mandatory minimum to be observed by students.*

## 8. CONTACTS AND OFFICE HOURS

*(Ana Maria Antão, anantao@ipg.pt, Gab.76, ext.1276, Laboratório de Geotecnia 1)*

## 9. OTHERS

*It is recommended caution in the practices carried out in the laboratories.*

**DATE**

**8 de novembro de 2023**

**SIGNATURES**

Professor

*Ana Maria Antão*